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# On the Melodic Relativity of Tones

BY

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# INTRODUCTION

Melody, in its broadest connotation, means any succession of single tones. Such a definition includes many examples of tonal combinations not considered melody by the musician, layman, or by the psychologist. The inclusion is necessary, however, in order to explain certain reactions to tones.

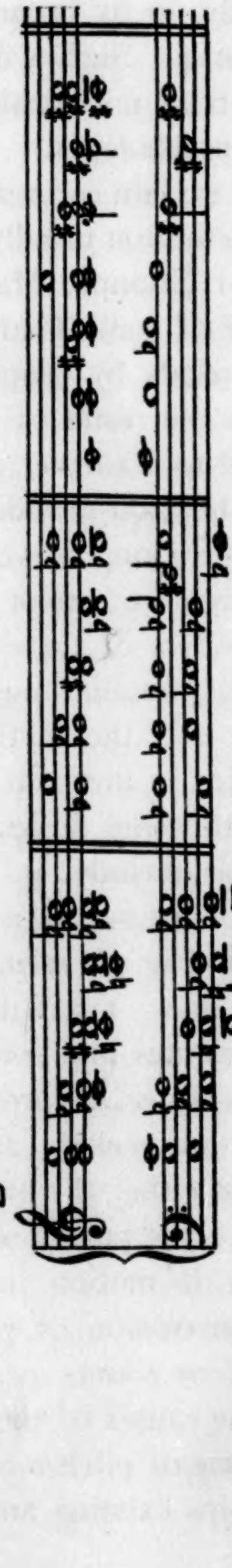
The definition usually given (we find it in various forms in the works of Stumpf, Mach, Bingham, and others) demands the existence of some finality, cadence, law of return, or acceptance of the melody by peoples at large. To some extent these attributes are the result of the operation of more basic psychological laws, and to a further extent they involve the operation of other musical, but non-melodic elements such as harmony, tonality, and rhythm. So long as we treat melody in connection with harmony and rhythm we cannot isolate any purely melodic factors. The striking effect of these attributes may be seen if we change the rhythm of familiar melodies. The following example, Fig. 1, of which only the rhythm has been changed in a simple manner (it remains in uniform meter [4/4] throughout), will be recognized with some difficulty as "America," and its acceptance as a desirable melody, in the form here given, is doubtful. The effect of harmony is no less pronounced. The following tonal sequences, Fig. 2, seem to be lacking in finality, coherence and musical value. Yet if they be harmonized, let us say as in Fig. 3, these attributes and some esthetic satisfaction appear. Similar, though perhaps less pronounced, effects are present in all artistic and folk-tune melody, and unless we exclude these attributes, we cannot use either the art-song or the folk-song as a basis for an analysis of the purely melodic relationship of tones.

Melody is motion in the pitch-series. This motion results from a succession of pitch distances or interval, in which the repeated tone counts as a zero interval. The problem here is not to seek the causes of the acceptance of some and the rejection of other forms of pitch-motion as desirable, but to seek the melodic relationships existing among the tones of any melody, regardless

Fig. 1

Fig. 2

Fig. 3



of its esthetic or form value. Melodic-relativity thus becomes the equivalent of pitch-relativity, and our problem is not the consideration of the melody as a whole, a musical or artistic unit, but of the pitch-relationship of each tone to all the other tones of the tonal sequence selected.

Since melody is pitch-motion, the attributes of the pitch-series will form the basis of the investigation. Chief among these is continuity. The pitch-series is a continuous stretch of sensory material, unbroken by any periodicity. Between C and C♯, for example, lies a short stretch of this series, which may contain any number of intermediate pitch-points. This is best illustrated by instruments such as the siren, the sliding intonation of which eliminates all pitch-points. Any "slide" thus produced (the natural example of which is the howling of the wind, and the musical example of which is the "portamento" of the voice or that of the violin) is an example of pure melody; pure because it is free from rhythmic and harmonic associations. In such a case, there is a continuous passage from one arbitrary end-point to another; and both ends may be so shifted as to cover the entire pitch-range or any portion thereof. As we reach 435 vibrations, for example, we call the tone A, but we shall also call 433, 434, 436, 437, and more vibrations, A. And so on until a stretch is reached over which we are in doubt as to whether the pitch is A or B♭. As we approach 460 we are certain of B♭, and A has vanished; but the change has been gradual, not abrupt. This means that our tone-names are merely convenient points along a continuous dimension, any point of which shades imperceptibly into its immediate neighbors. Our tones are not separated by empty spaces, they are not even clearly defined as points, for each has its "fringe."

With this view in mind, we may profitably proceed to an enumeration of the most important absolute factors governing the melodic relativity of tones.

# PART I

## Static Aspect of Melody

### *Absolute Factors*

*First and Last Tones*—In any succession of sensory stimuli the first and the last are accentuated for consciousness because the difference between *no* sensation and *a* sensation is greater than the difference between any two sensations in the same sensory field, so long as intensity remains constant. The first and the last tones of a melody, therefore, are projected more vividly upon consciousness than any intermediate tone. They represent the points where sound breaks silence and silence breaks sound. Elaborated into higher mental reactions, this relationship leads to primacy and recency as efficient factors in recall, the former being illustrated by the proverb: "First impressions are lasting." The first and last tones of a melody mark the end-points of the auditory series, and more than other tones, they bound the melody.

*Highest and Lowest Tones*—In the pitch-series the highest and the lowest tones are the psychological equivalents of the first and last tones in the temporal series. Above the highest and below the lowest tones is a stretch of unstimulated sensory field, while on the other side of each there is a sensorial stimulation. Again we have the condition of no stimulation against various degrees of stimulation. This results primarily from the one-dimensionality of the pitch-series, which forces one of any three tones to lie between the other two. Two pitches, therefore, will form the extremes in any group, and these extremes, for reasons similar to those given for the first and the last tones, are accentuated for consciousness.

This concept is not in conflict with the extensity theory of pitch, because the stretch of tectorial or basilar membrane between the fenestra ovalis and the point stimulated by the highest tone is just as unbroken *by other pitch points* as that between the lowest tone and the apical end of the membrane. On the other hand, in

thus combining the highest and lowest tones into a single class an impression of psychological equality may be conveyed, which, in all probability, is not true to fact. For the volume attribute of tones makes any higher tone a " part of " any lower tone. The extensity theory of pitch explains the physiology of this by assuming that the same stretch of tectorial or basilar membrane innervated for any tone is also innervated for any lower tone, plus an additional stretch of membrane. The emphasis for the highest and the lowest tones may therefore differ in degree; but in any case, both highest and lowest tones are emphasized, in comparison with the intermediate tones, as the end-points of the pitch-series involved.

*Tone-Repetition*—Repetition of any stimulus strengthens its impression upon us so long as the repetition is not sufficiently pronounced to produce fatigue. Repetition is the *sine qua non* of the Drill Method of instruction, the value of which, whatever be its shortcomings, is real. It explains frequency as another factor in efficient recall. I doubt that true repetition ever weakens a preceding impression, even when prolonged sufficiently to produce monotony and *ennui*. What happens in such a case is that the new impressions, those of the most recent repetitions, *are* weaker than the earlier ones, and hence may strengthen the earlier impression but little, but they do not, therefore, weaken the earlier impressions. Constant working with a single pitch, carried on long after fatigue or monotony has set in, will none the less, often result in the subjects acquiring a memory for this pitch. Thus violinists, who otherwise do not possess the so-called " absolute pitch," not infrequently recognize their one-lined A without difficulty, this being the tone from which they always tune. For a similar reason orchestral conductors may recognize a very slight " sharpness " or " flatness " of the A of the oboe, the instrument from which the orchestra " tunes," whereas they might not detect these minute differences if the A be played on some other instrument. Piano teachers often recognize the " absolute-pitch " of tones on the piano, but not on other instruments. Repetition in these cases has been the chief

factor in retention, and improved retention in simple sensorial stimulation means that the original stimuli are summated.

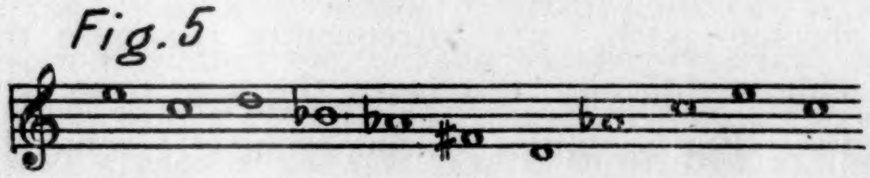
The degree to which repetition gives emphasis to a tone, depends, in part at least, upon the number of repetitions. The last E's in the two examples of Fig. 4 make different impressions as a result of differences in the number of repetitions.

Fig. 4

A single repetition is not without some effect, although this may then be so slight as to escape notice.

In any melody the three types of absolute emphasis: the first-last tone emphasis (time-extreme emphasis), the highest-lowest tone emphasis (pitch-extreme emphasis), and the repetition emphasis, are usually all present. The first two must be present in every real melody, the third may or may not be present. When any two types of emphasis coincide for one or more tones, these tones are correspondingly doubly accentuated. If, on the other hand, the types of emphasis do not coincide, the psychological status of that tone is correspondingly weakened.

Fig. 5



In Fig. 5, the tone E is thrice accented: through pitch-extremity, primacy, and repetition. The A♭ is accentuated through repetition, but weakened, in comparison to the highest and the lowest tones, by pitch-intermediacy; while the C is emphasized through time-extreme and repetition, and weakened through

pitch-intermediacy; and the B♭ is unaccented by any of the three factors. Obviously, other combinations are possible, the ultimate degree of accentuation depending upon the coincidence or non-coincidence of the three types of emphasis. A further modification is caused by a probable inherent difference in the absolute degrees of intensity of the various types of emphasis. We cannot well compare the degree of emphasis which pitch-position gives with that which time or repetition gives, for we are here dealing with fundamental sensorial material, which does not lend itself to direct comparison. The difficulty is like that experienced when we attempt to compare the intensity of a light with that of a tone. Accordingly, in addition to the subjective difference in intensity between the highest and the lowest tone, resulting from differences in tone-form (2), a highest or lowest tone may be *per se* more or less emphatic than a first tone or a repeated tone.

### *Relative Factors*

Tones are associated as all sensory data are associated: by similarity and by contiguity. In the auditory field, association by similarity is the equivalent of contiguity in pitch. Among the attributes of tones is tone-form, the resultant of pitch and intensity (2). When intensity remains constant, the tone-form changes with pitch. Small pitch differences mean great similarity of tone-form. On this basis, middle C, for instance, is most closely associated with its immediate pitch neighbors, small B and one-lined C♯. It is but remotely associated with contra B or three-lined C♯. In the first case the pitch difference is but a half-tone, in the latter case it is several octaves. The degree of association varies inversely as the pitch difference, or pitch distance. It is unbroken by any periodicity, such as octave-relationship, or fifth-relationship. These are harmonic in nature, that is to say, they depend upon reactions to simultaneous tones, and are then transferred, in a modified form, into the melodic field. The purely melodic association with which we are here concerned is made possible by the continuity of the pitch-series, and the strength of the association by the complete tonal identity which is reached when we make the pitch difference small enough.

Thus, if the pitch difference between two tuning forks be small enough, the subject will react to the two tones as "the same tone," which is the equivalent of ideally complete association, *i.e.,* identity. A musician will find it difficult to admit the association by pitch-proximity. This is because any tone, to him, at once suggests one or more harmonic backgrounds, thereby introducing non-melodic elements; and the same holds for tones of any artistic melody.

Association by contiguity-in-time causes a tone to be most closely associated with its immediate predecessor and successor, and remotely associated with tones far removed from it in point of time. Here, too, the scale of association is continuous; unbroken by metrical symmetry or rhythmic parallelism, both of which result from dynamic and temporal variation, factors which are excluded from consideration here, because they are the agogic equivalents of tonality and scale, and, as such, fall beyond the scope of pure melody.

*Interval*—Whenever two tones are heard in succession at such a rate that the impression of the first is still present when the second tone sounds, a sensation of interval results. This means that a pitch distance between the two tones is consciously recorded. In music this relativity is much more important than the recognition of any one pitch-point, and may help to account for the preponderance of relative-pitch over absolute-pitch. Melodic memory (relative-pitch) is a capacity frequently found, whereas the existence of tone-memory (absolute-pitch) is relatively rare. The normal individual cannot, for example, name the exact tones or key of a composition by ear, but has no difficulty in humming a short unfamiliar melody immediately after presentation, or a familiar melody after delayed recall.

Accordingly, in an analysis of the reactions to melody, it is logical to expect the relative factors to function more often, and with greater effect than the absolute factors. Relationships among tones will play a more important part than the absolute position of any tone, in either the pitch- or the time-series.

Intervals are associated as separate tones are associated, by contiguity in pitch and time. A melodic major third, for example,

is most closely associated with a minor third (augmented second), and with a perfect fourth; because the pitch distances are most nearly equal. It is next associated with a major second and an augmented fourth (diminished fifth). Here, again, we must guard against letting our *harmonic* associations (thirds with sixths, fourths with fifths, seconds with sevenths) interfere with this purely melodic conception. The association of the major third with the minor third, for instance, or with the perfect fourth, is the closest possible one in our musical system of half-tones. But, as in the pure pitch association, many other intervals are conceivable between the major third and the minor third or the perfect fourth, and these associations would be stronger than those given for the half-tone. Again it will be difficult, even impossible, for the trained musician to think of melodic intervals independently of their harmonic equivalents, but the reality of this type of association, too, may be experimentally proved. Thus the pitches of two tones may be altered slightly until, let us say, a minor third, by imperceptible increments, changes into a major third and then into a perfect fourth. We recognize the change *after* a certain *stretch* of interval has been passed, but cannot designate any exact point at which the change takes place; this part of the change being ambiguous, and partaking of the characteristics of both intervals. In vision, for example, we may recognize a certain distance as a foot. But we also recognize a distance of 12.1 inches as a foot if measured by the eye alone. After a certain ambiguous range we react by describing the distance as more than a foot. The case of auditory interval, which is nothing else than distance along the pitch-series, is governed by the same principle. Since the tones themselves with their physical basis are stronger than the interval reaction, we more readily think of this type of association in terms of tones (pitch-proximity) than in terms of interval. For the same reason we think of three unequally spaced points in vision as "two closer together than two others." That is to say, the points rather than the distances between them, occupy the focus of consciousness.

Through contiguity in time, an interval is associated most closely with the intervals immediately preceding and following it,

just as a separate tone is associated with the tones immediately preceding and following it.) The contrast, for example, between a major second and a fifth is more noticeable, is reacted to as greater, if the two intervals are in immediate succession, than if they are separated by other intervals of thirds and fourths. In the first case association by contiguity in time is at its strongest point. In the latter case it is weakened because the intervals are no longer contiguous in time but are separated by intervals the absolute values of which fall between the two. In one case the transition is abrupt, in the other case it is gradual. This holds for sensations in any field.

*Pitch Direction*—The most characteristic attribute of auditory sensation is pitch (3), and the most characteristic attribute of melody (pitch-succession) is motion. This motion is basically described as ascent and descent (2). The idea of opposites herein conveyed results from the one-dimensionality of the pitch-series. The most fundamental thing that we can say about the pitch of two tones is that one tone is higher or lower than the other. And, for the same reason, the most fundamental pitch-change in a group of tones is a change in pitch direction from ascent to descent, or the reverse. This fundamentality is at the bottom of the test in pitch discrimination usually given as one test for musical talent, in which the subject merely reacts to the second of a pair of tones as "higher," or "lower" than the first; and the relative ease with which the test can be given, from the standpoint of comprehension and adaptability, as well as the curves of distribution and coefficient of variability which have been obtained, point to this judgment as a fundamental one. In the other sensory fields, similar judgments are equally fundamental. In vision, we react to the direction relationship between points as soon as we react to the points themselves. One point then is to the right or to the left, above or below the other. In kinesthesis, one weight is either lighter or heavier than the other. And the tendency to project the direction relationship between two points in an unbroken or straight line is the explanation of several of the well-known optical illusions (3). This tendency, in turn, results from the fact that the simplest linear relationship is that

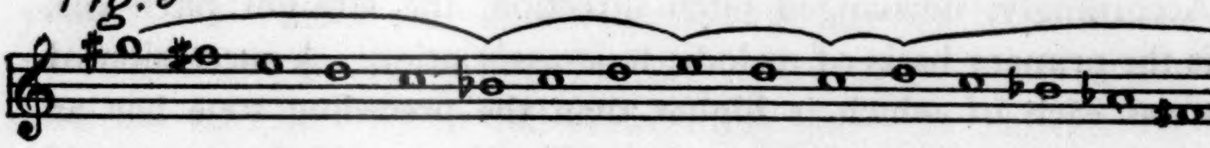
of the straight line. The straight line, in consequence, represents the greatest degree of unity. It is not subdivided at all (4). Now, if we accept pitch as transtensity, that is to say, as that attribute of sensation determined by the amount of stimulated membrane affected, the reactions to the auditory direction relationships will be similar to those in the visual field (5, 6, 7, 8). Accordingly, unchanged pitch direction, the straight pitch-line, is the primary basis of melodic tone-association. A succession of tones each of which is higher than the preceding tone has an attribute common to the entire melody, viz., pitch-ascent. If each tone is lower than the preceding tone, pitch-descent is the common attribute. As we shall see later, the contour of a melody is fundamentally determined by pitch-ascent and pitch-descent.

In the study of voice-leading, which is the melodic aspect of music, one learns three types of tonal motion: parallel, contrary, and oblique. In terms of pitch direction these are, respectively: ascent *or* descent; ascent *and* descent; and ascent or descent with horizontality. This classification occurs at the very beginning of instruction probably because it represents the most basic melodic relationship. And many of the later rules of chord or tone succession, which point out the undesirable progressions, may be explained on the basis of a change in pitch direction. Among them are such well known instances as *parallel* octaves and fifths; the approach to the seventh of the chord; the descent of the leading-tone; wide skips; the violation of the natural tendencies of certain scale degrees; and two fourths or fifths in succession in the bass (9, 10, 11, 12). In each case a change in pitch direction will eliminate the undesirable feature of the progression.

If straightness of pitch direction is the basis for unifying tones, then a change in pitch direction becomes the prime determinant of melodic tone-groups. A melody ascends, descends, or progresses horizontally. In thus moving, it creates melodic outline. This auditory outline is most uniform when there is no change in pitch direction; it loses uniformity with each change of pitch direction. The amount of disjunctiveness thus produced depends upon the amount and frequency of change in pitch

direction; small changes in pitch direction will obviously produce less disjunctiveness than large changes. However, each change of direction, be it great or small, acts as a point of disjunction, separating the melodic groups. This grouping, in its simplest form is illustrated in Fig. 6.

*Fig. 6*



Any unnaturalness in this grouping, which the trained musician will experience, results from the admixture of group-determinants other than that of pitch direction. These will be discussed later.

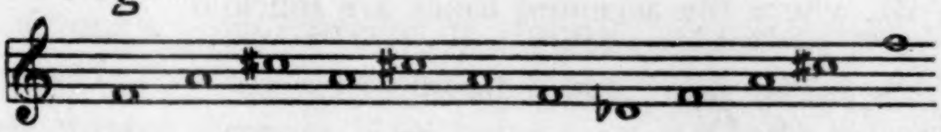
*Pitch-Proximity*—Tones are further associated on the basis of pitch-proximity. The nearer the pitches of two tones, the stronger is the association. Two tones of widely different pitches are dissociated. (Not dis-associated, which is an active taking-apart, whereas dissociation means merely the absence of association.) Here again, a comparison with the visual field will make this clear. In vision, three points unequally spaced are grouped 2–1 or 1–2, on the basis of space-proximity, and not 1–1–1. Four points, unequally spaced, are primarily grouped 3–1, 1–3, 2–2, but not 4–0 or 0–4. The auditory equivalent of such grouping is proximity in pitch, and, accordingly, tones are associated on the basis of nearness of pitch. Such grouping is shown in Fig. 7.

*Fig. 7*

The clearness of definition of these groups depends upon the ratios existing between the pitch differences of any group and the pitch difference between the groups. If, for example, the tones within a group are all separated by half-tone steps, and the next group begins at the interval of a tenth, the demarkation would be very pronounced. If, on the other hand, the tones of

a melody are all at the same distance from one another, then no grouping on the basis of pitch-proximity can take place. Such a condition is shown in Fig. 8. (The grouping, if any, in this

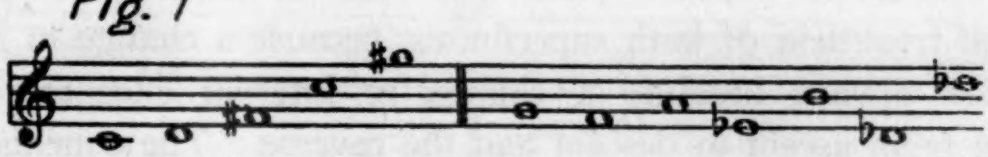
Fig. 8



melody, is the result of a change in pitch direction and of repetition.) Between the extremes shown in Figs. 7 and 8, all degrees of intermediacy may occur, resulting in a scale of group-definition that shades from very marked into zero definition. It is obvious that this is but the reverse side of the interval-association, because pitch-proximity necessarily means smallness of interval. In view of this fact it might be advisable to discard the interval viewpoint entirely. However, certain reactions to tones, which we shall have to consider, can be analyzed somewhat more clearly by using the interval as a basis. In thus keeping the two distinct, I do so solely for practical, not theoretical reasons. Theoretically, only one principle is expressed.

When tones are arranged in the order shown in Fig. 9, a grouping on the *basis of pitch-proximity* cannot occur, in spite of the fact that the pitch distances vary. Here the *change in interval* is a constant, forming an arithmetic series with either a+ or a —*d*, and thus preventing the formation of any second group.

Fig. 9



If grouping takes place at all, under such conditions, each added tone is linked to the preceding, forming either one whole group, or shorter groups of two tones each; C with D, D with F♯, F♯ with C, C with G♯. But such an association is not one of pitch-proximity, but of temporal proximity, a form which we shall consider later.

*Emphasis in Tone-Groups*—Pitch-extreme, time-extreme, and repetition emphasis affect the individual tone-group in a manner

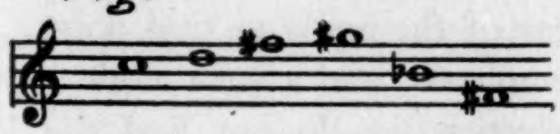
similar to that for the entire melody. Thus the first and last tones of a group, the highest and lowest tones, and any repeated tone within the group become accentuated in relation to the remaining tones of the group. These relationships are shown in Fig. 10, where the accented tones are marked.

Fig. 10

*Interval Relationship*—The existence of interval sensation, as distinct from the sensations of the two pitches involved, is as real as the existence of distance in the visual field. But if we grant the existence of interval sensation, then we must likewise grant the existence of interval retention and of interval comparison. Intervals are not only perceived, they are also remembered and compared. The emphasis, therefore, which the first and last tones, highest and lowest tones and repeated tones, receive, may be similarly applied to the first and last, highest and lowest, and to repeated *intervals* of the melody. As a result, the tones adjoining the first and the last tones, and those adjoining the highest and the lowest tones of the melody are accentuated, since an interval cannot be separated from its pitch boundaries, and as soon as an interval is given, two pitches must be given. This connection between pitch and interval makes a separate detailed treatment of both superfluous, because a change in pitch direction always involves a change in interval excepting the change from ascent to descent and the reverse. The conclusions drawn under pitch direction may therefore be explained as change in intervals also. However, interval introduces emphases other than those of pitch direction, and these need to be mentioned.

On the basis of pitch direction, the emphasis of a tone remains unchanged so long as its immediate environment remains unchanged. It does not change with the absolute position of the tone in the melody. Interval, on the other hand, does introduce such a change. In Fig. 11, the D and the B♭ are not accentuated

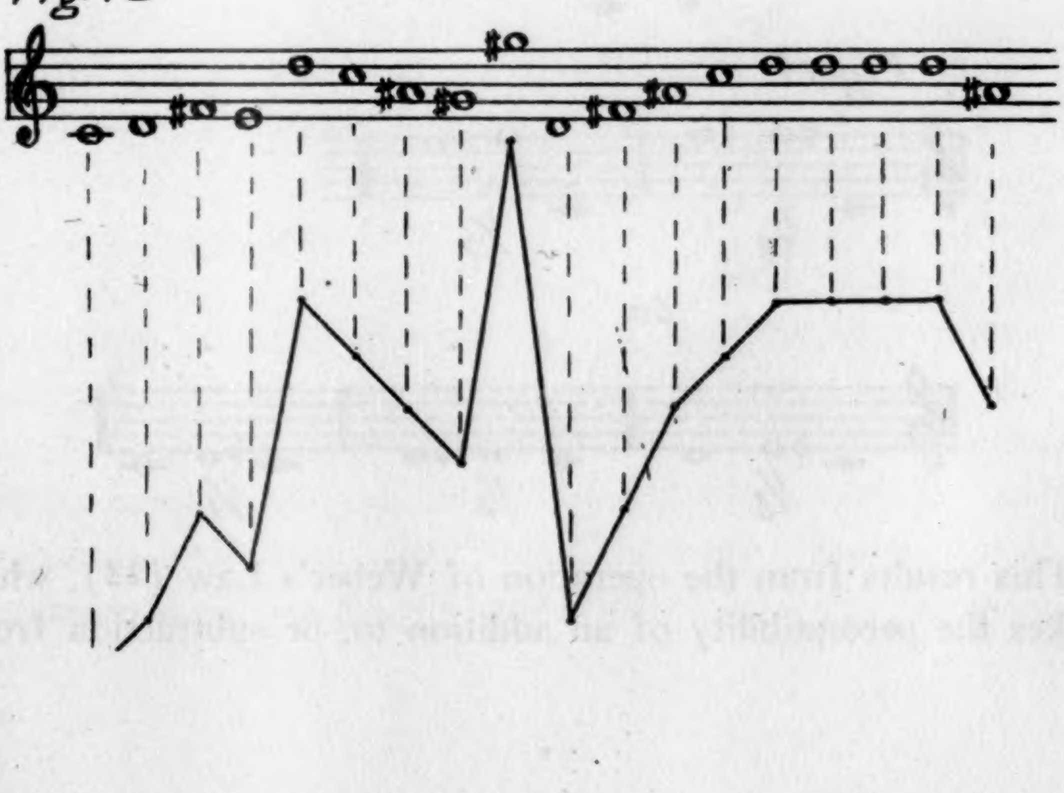
Fig. 11



either through pitch-extreme or through time-extreme, since in both respects they are intermediate tones. But the D and the B♭ are accentuated because they belong to the first and the last intervals of the melody. For a similar reason the tones preceding and following the highest and the lowest tones are accentuated; in Fig. 11 these would be F♯ and B♭. One must remember, however, that the strength of these stresses depends upon the entire tonal environment, in which other types of accentuation may be so pronounced as to annihilate the interval emphasis. Generally speaking, the tones adjoining an emphasized tone, are in turn emphasized through interval relationship, though, normally, the melodic type of this emphasis is weak.

*Degrees of Emphasis*—The theoretical strength of tonal emphasis may be determined either on a basis of change of pitch direction or on a basis of interval relationship. In the former case, the degree of emphasis depends upon the acuteness of the pitch angle. This is best shown by projecting pitch upon the vertical dimension of the visual field, and tonal sequence upon the horizontal dimension.

Fig. 12



The emphasis of any point in the outline of Fig. 12 depends upon the acuteness of the angle at that point. A straight angle represents zero emphasis, and a zero angle represents maximum emphasis. In practice we do not find the latter, because an integral part of melody is succession, and succession makes a zero angle impossible. The projection shown in Fig. 12, so far as linear relationships are concerned, is an adequate counterpart of the auditory experience, and the points that " stand out " for the eye are exactly those that stand out for the ear. A direct comparison between the two is made possible by the extensity theory of pitch. However, the absolute dimensions of Fig. 12 are, of course, arbitrary.

If we use interval relationship as the basis for determining the degree of tonal accentuation, this may be measured by the ratio between two intervals. Assuming the pitch range of a melody to be approximately that of the average human voice, namely, a twelfth, the smallest ratio of interval change, in a system the smallest interval of which is the half-tone, would be as 1:19. This ratio is shown in Fig. 13. As we decrease the original interval, the half-tone increment assumes increasing importance, as in Fig. 14.

*Fig. 13*

*Fig. 14*

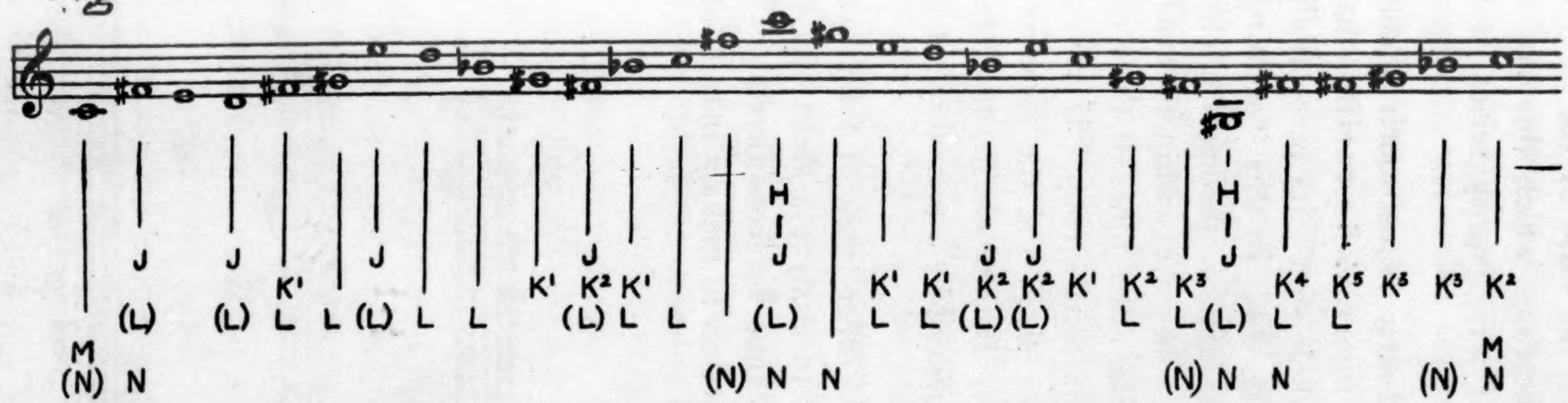

This results from the operation of Weber's Law (13), which makes the perceptibility of an addition to, or subtraction from,

a stimulus depend upon the ratio of the increment to the base. In spite of the modifications which this law undergoes as we approach the limits of any sensory series, it is fundamentally valid.

Accordingly, a half-step seems much smaller, for example, when preceded by the interval of a twelfth, than when preceded by the interval of a whole-step. Its perceptibility depends upon the ratios shown in Fig. 14. In this " seeming-smaller " is the explanation of the association through pitch-proximity. The more proximate three tones are within themselves, and the less proximate they are to the other tones of the melody, the stronger will they stand out as a tonal group. If we turn once more to the optical illusions, we shall find the same principle operating in many of them (3). In kinesthesis, too, the reaction to any absolute weight is influenced by a preceding or succeeding weight (24).

Before proceeding to other types of tonal emphasis, it will be advisable at this point to analyze a short melody, combining all the types of emphasis thus far considered. The complexity of our purely melodic reaction to melody may then be seen.

Fig. 15




In Fig. 15, H = absolute pitch, very high or very low; I = highest or lowest tone; J = change of ascent to descent or v.v.; K = tone-repetition; L = interval relationship, or minor pitch change; M = first and last tone; N = first and last, highest and lowest interval.

## PART II

### Temporal Aspect of Melody

Thus far melody has been analyzed from what may be called its static side. The pitch series alone has furnished the variations, while the temporal series has been considered as a constant. In actual music, of course, such is not the case. Accordingly, we have now to consider the effect of this temporal extent upon the types of emphases thus far considered; for our definition of melody included not only pitch variation, but also, and that necessarily, pitch succession.

A melody must have duration or extent in time. Inseparably interwoven with this extent are the psychological problems of immediate memory, recall, and anticipation, because consciousness never contains only the material in the focus, but also that in the fringe of the mental field (14).

Generally speaking, our reaction to a stimulus diminishes in intensity as the time between the presentation of the stimulus and any present moment increases. It is this phase of reaction, as we have seen, that denominates recency as a factor in vividness of impression. The basis of this vividness is found in the association by contiguity, which operates in the agogic series as well as in the pitch-series, and causes any tone to be most closely associated with its immediate successor, and less closely associated with tones further removed in temporal extent.

*First and Last Tones*—The emphasis which, by virtue of these positions in the melody, the first and the last tones of a melody receive is counteracted, so far as the first tone is concerned, by the temporal factor. Since the first tone is always the tone farthest removed from the objective presentation of other tones, its projection in consciousness is weakest. If the melody be sufficiently long, that is to say, if it quite exceeds the memory-span, the first tone, in spite of its original emphasis, will be lost for consciousness. The last tone, on the other hand, receives a double emphasis, because to the accentuation of boundary tone

of the sensory series, is added the accentuation of greatest recency. Immediately after the completion of a melody, therefore, the first tone has passed through all stages of agogic emphasis, from maximum to minimum, while the last tone stands at maximal emphasis.

*Highest and Lowest Tones*—In a similar manner the original stress which the highest and the lowest tones of a melody receive through their positions in the pitch-series, gradually diminishes as the melody proceeds, unless it is reënforced through repetition, until it, too, may be replaced by the recency-emphasis of some pitch-intermediary. And of the two tones, that one having the greater recency, other things equal, will be the more emphatic. But this effect works also the other way. If the difference in pitch-extreme accentuation originally be great enough, it will overcome the recency-emphasis just referred to. In Fig. 16, in spite of the greater recency of the low B♭, the very marked pitch accentuation of the high G♯ may suffice to retain the latter tone in consciousness more vividly than the former tone.

Fig. 16

Here again the greatest emphasis results when the two types of stress coincide; when, for example, the last tone is also the highest tone. This is very characteristic of many dramatic melodies. One need only recall, for example, the "Eri Tu" from Verdi's Masked Ball, the "Celeste Aida," the close of Tristan and Isolde, the optional end of the Lucia Sextette, or Mendelssohn's "Hear Ye Israel." When this coincidence is absent, the accentuation for any one tone is correspondingly less.

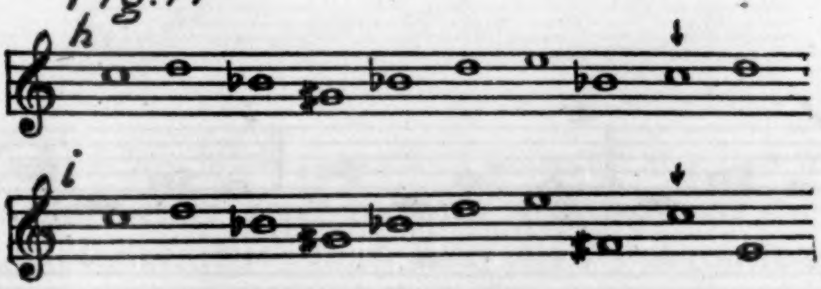
*Tone-Repetition*—Considered in its temporal aspect, the emphasis which a tone receives through repetition depends, first, upon the time-interval between the repetition and the original presentation of the tone; secondly, upon the number of repetitions; and, thirdly, upon the pitch-emphasis status of the tone

at any presentation. That it depends upon the length of time interval may readily be shown by giving a subject a series of discreet tones, in which the repetition of a given tone is to be noted. As the time-interval increases the recognition will become more and more uncertain until, finally, it is entirely lost. A preliminary survey of this difficulty has shown that, with a single presentation of the tone, and the series played at the rate of one tone per second, very inferior pupils " forget " the tone after seven seconds, while superior pupils (not possessing the so-called absolute-pitch) recognize it after 21 seconds or more. It is this variation that forms the basis of many memory tests (**15**, **16**). Variations in the types of emphases discussed in Part I, of course, can modify this relationship between difficulty and length of time-interval.

The dependence of stress upon the number of repetitions, provided that they be recorded as repetitions by the subject, has already been mentioned. It is the " frequency " emphasis, and is not complicated by temporal considerations other than that each repetition is subject to the variations mentioned in the preceding paragraph.

The third element in repetition-emphasis, however, is less simple. It depends upon the pitch status of each presentation. In Fig. 17, the repetition of C will be recognized more readily in *i* than in *h*, because in *i* the second C is already emphasized through change of pitch direction and size of interval, whereas in *h* the second C is unemphasized in these respects.

Fig. 17




For a similar reason, the tone C, Fig. 18, *i*, is more accentuated finally than the C in *h*, because in the former each presentation of the tone is stressed through lack of pitch proximity with ad-

joining tones, whereas in *h* pitch-proximity tends to obscure the individuality of the tone at each presentation, linking it more closely to the other tones of the melody.

Fig. 18


Thus the mere fact that a tone has been repeated four times does not mean that the fifth repetition will be equally strong in all cases. The degree of final emphasis can be determined only if we know the tonal environment of each presentation of the tone.

---

The influence of the temporal series upon the psychological status of any tone of a melody is seen clearly when we construct a melody tone by tone, which is the way in which it is heard, if we exclude the play of anticipatory imagery. In Fig. 19 *i*, the F♯ is accentuated as last and again as highest tone. In *j*, it remains emphasized through change of pitch direction. In *k*, this is lost, because of the higher G♯. In *l*, the F♯ is reënforced through repetition; in *m*, it is weakened as intermediate tone; and in *n*, it is again reënforced by repetition.

Fig. 19


Each tone in any melody undergoes similar changes. It follows that the status of a tone in consciousness is not controlled

by any one series, either pitch or time, but is modified by the tonal environment. The same conclusion applies to any group of tones, and, incidentally, to any chord or group of chords (17).

Thus *the psychological status of any tone of a melody is not a constant.*

*Higher-Units*—Association of tones into higher-units is strongest when both types of association—contiguity-in-pitch and contiguity-in-time—are present for the same group of tones. In Fig. 20 *h,* the tones can be associated only through contiguity in time, since the interval relationship (wide pitch difference) makes pitch association (not harmonic association) impossible, or at best weak. In Fig. 20 *i,* the reverse is true. In this example, according to association in time, the tones would be linked: 1–2–3–4–5–6–7–8–9. But the marked pitch-proximity among tones 1–3–5–7–9 and among 2–4–6–8 is sufficiently strong to replace the time-grouping, so that the ear " hears " the two melodies (outlines indicated by the dots).

Fig. 20


In Fig. 20 *j,* the pitch-proximity between any two tones of the melody is sufficiently great to make a division of the tones into two melodies impossible. Such an analysis and synthesis are being constantly used in listening to music. As a result thereof, objective pitch-descent may become psychological pitch-ascent, and vice versa. For, in associating tones 1 and 3, we bridge over the tone 2, otherwise tones 1 and 3 could not help to form a melody

(interval). The descending major tenth (F♯ to D) is replaced by an ascending major second (F♯ to G♯); and the ascending eleventh (D to G♯), by a descending second (D to C). One effect of such a substitution is that a violently jerky melody with its resulting emotional restlessness, may thus be replaced by two smooth melodies with their opposite emotional counterpart.

The strength of this type of association is determined, on the one hand, by the ratio between the pitch association and the time association, and, on the other hand, by the relationship between the intervals of either melody and the intervals between the two melodies. In Fig. 21, poor association in time weakens the upper

Fig. 21

melody considerably but not the lower. In Fig. 22, poor associa-

Fig. 22

tion in pitch makes a division into two melodies impossible, since the intervals of either intended melody would be as great as the intervals between the two melodies (major third or augmented fourth and diminished fifth). The tones A♭ can equally well belong to the higher or lower melody. The smaller this ratio between the intervals *of* a melody and the intervals *between* two implied melodies, the more pronounced are the individualities of the melodies. In Fig. 22, the ratio is 1:1, at which point no grouping whatever takes place. (Contrast this with the clear definition in Fig. 20 *i.*)

*Tempo*—Intimately connected, of course, with all considerations of temporal relation is the question of tempo. This does not introduce any new elements, but does modify the relation-

ships which we have discussed, by increasing or decreasing the absolute time value of any tone or any group of tones. By so doing, it may increase or decrease the memory-span, and thus alter the size and quality of the tonal higher-units. We are here very close to rhythm, for the law upon which such grouping is based is at the same time the fundamental law of rhythm: that short tones are more strongly grouped than long tones. In this connection the deductions and examples of Parts I and II presuppose a constant tempo.

*Intensity*—A further important element is intensity. Treatment of its effects, like that of tempo, is here omitted because the aim of the discussion is an analysis of the purely melodic (pitch) aspect of melody. Both tempo and intensity are mentioned, however, because either may readily overthrow the reactions which have been enumerated. A tone unemphasized as pitch intermediary, for example, may overbalance the highest or the first tone, if it be given intensity accentuation. In fact, since intensity is the sensorial reaction to the dimension directed toward the end-organ (the degree to which an end-organ or group of end-organs is affected), and has, therefore, greater biological significance, it is probable that a slight increase in intensity will outweigh a considerable increase in pitch or time emphasis. The deductions of Part IV also presuppose the same careful separation of the rhythmic from the purely melodic elements of melody.

## PART III

### Influence of Extraneous Factors

The various types of tonal relationship which we have considered color or modify our reactions to any series of single tones. In music these reactions are further modified by harmonic and rhythmic influences, both of which are to be excluded here as far as possible. Complete elimination, however, is impossible, for reaction to melody is a psychological phenomenon, and the integrative action of the organism excludes complete isolation of any one factor. In the first place, it is impossible to select an example of pure melody on any musical instrument tuned to the tempered scale. Pure melody must be an atonality melody, which means one outside the tonality scheme (not anti-tonality). As soon as we introduce the smallest fragment of key or tonality, we introduce harmonic imagery. Now, there is no interval in the tempered chromatic scale which is not found, or the enharmonic equivalent of which is not found, as an interval of our diatonic scale. The augmented-fourth, even, occurs between the fourth and the seventh degrees of the scale and immediately suggests, among other things, resolution into the third and eighth degrees, as a result of harmonic associations (dominant-seventh-chord into tonic-triad). The first two tones of any melody, regardless of the interval between them, may, and most often do, suggest tonality relationships, by being heard as certain tones of an imaged scale, which may or may not counteract the purely melodic relationship between the two tones. The same thing holds for any other tone or group of tones in a melody.

Now these intervals, through differences in the frequency of their use and their harmonic importance, vary in their associative importance. A second or a third is much more vivid as an associative link, that is to say, either interval awakens tonality associations more readily than the augmented-fourth, because, among other things, the former are more frequently used in melody than the latter. If we select any good melody, we shall

find the melodic steps of an augmented fourth or a diminished fifth less used than those of seconds and thirds. In each of the following examples, which include all possible cases for a whole tone octave, tonality associations function: C–D; C–E; C–F♯; C–G♯; C–A♯. On a purely melodic basis, the strongest association is the diatonic one, since this also represents the greatest tone-similarity through pitch-proximity, excluding only tone-repetition. It is interesting to note in this connection, that diatonic progression excuses many otherwise forbidden harmonic progressions, such as the violation of the natural tendencies of active tone-steps (18), successive doubling of the bass in sixth chords (19, 20), and the II–V–I progression with the 6–7–8 soprano (21), rules with which students of harmony are familiar. Next in importance is the interval of the third, since it represents the second of the two fundamental harmonic relationships (25). For present purposes we may limit it to the major third, because the minor third is excluded from the whole-tone scale, which has been adopted here in order to eliminate tonality associations as far as possible. And, since chords are built in an ascending direction, we may expect to find the strength of association for the third differing with the direction of the interval. An ascending major third will awaken stronger tonality associations than a descending third, other things equal (22). The order of the other intervals in regard to their associative importance is not so clearly determined, since the frequency of their use varies considerably.

In order to secure some concrete data on the actual frequency with which the various intervals are used in artistic melody, a count of one hundred and sixty songs was made, on the assumption that composers in selecting tonal sequences for melodies must follow melodic relationships, and also that frequent presence of certain intervals, in turn, strengthens the association between the tones of these intervals for the hearer. The composers selected were four of the best song composers, Schubert, Schumann, Brahms, and Richard Strauss, and the works chosen contained most of their best songs and some less well known. Approximately twenty-three thousand intervals were counted. This,

of course, would be too small a number to warrant generalizations if the various coefficients of deviation and dispersion showed wide variation. But the opposite is the case. Thus unisons or seconds were first in frequency in 97½ per cent. of the songs, thirds leading in the remaining 2½ per cent. The frequency orders: unison, second, third, fourth; or second, unison, third, fourth, were found in approximately 60 per cent. of cases. Such uniformity gives considerable general value to the count as made, and reveals clearly the presence of a melodic relationship of fixed order.

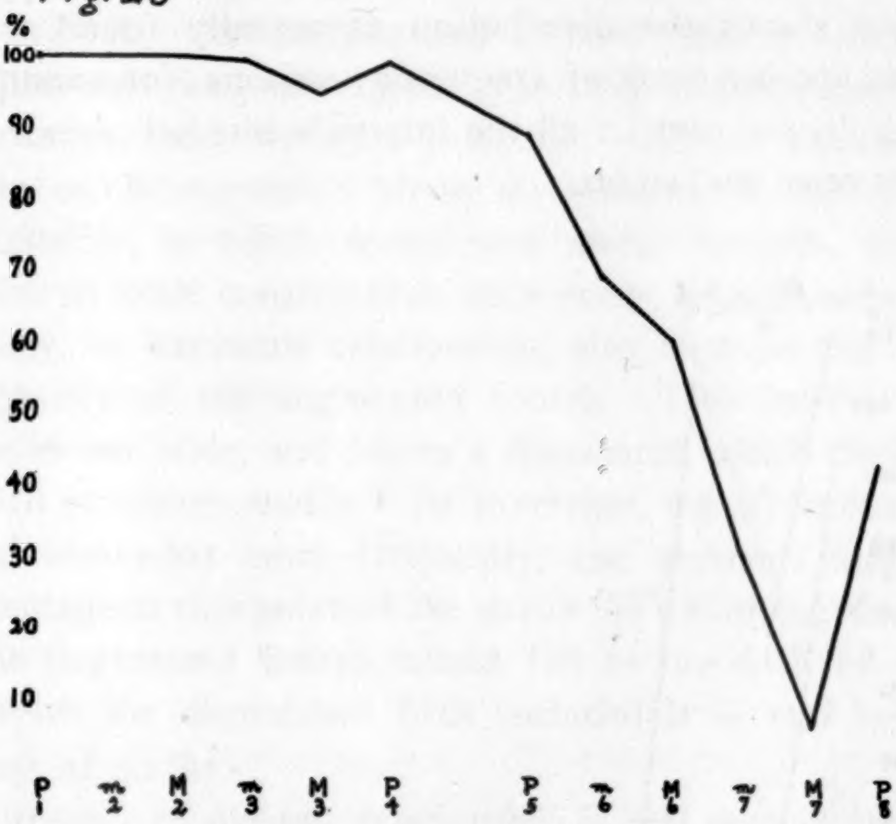
The first of the accompanying two figures (Figs. 23 and 24), shows the percentile distribution of the presence of each interval in the songs taken as a whole; that is to say, the number of songs out of the total in which the interval was present once or more often. The second figure shows the percentile distribution of the intervals themselves, thus taking into account the actual number of times in each song that the interval was present.

The figures are to be interpreted as follows: If the melodic relationships outlined in the preceding pages actually exist and operate in artistic music, then, in melodies (songs) small intervals should predominate markedly over wide intervals. This they should do regardless of their harmonic (fusional) value. The interval of a second, although a dissonance, should occur more frequently in a melody than a third, although the latter is a much better harmonic interval. A seventh, the harmonic equivalent of a second, should occur rarely in a melody on account of the remote pitch-proximity between its tones. Thirds and sixths, considered generally interchangeable from a harmonic standpoint, should show a marked preference in frequency for thirds, whose melodic relationship is more than twice that of sixths. A more pronounced form of this difference should be found for unisons and their harmonic equivalents, the octaves. Between fourths and fifths the difference will be less, because the melodic relationships of the two intervals are more nearly equal, but should still be in favor of fourths.

In Fig. 23 the essential features of melodic relationship, as found in the melodies selected, are shown. Distances along the

axis of ordinates represent the number of songs in per cent.; distances along the axis of abscissas represent the intervals. In this figure only the most frequently used intervals of the diatonic scales are included because the curve is intended to show only the central tendency of melodic relationship.

*Fig. 23*




Two deviations from the expected distribution, one slight, the other more marked, need explanation. The increase of fourths over major thirds is the result of the operation of harmonic relationships, the fourth (as inverted fifth) playing an important rôle in our harmonic system. The increase of the octave over sevenths shows this more clearly. Harmonically the octave is the most fundamental interval (except the unison) whereas the seventh is a dissonance. Melodically the two intervals have almost the same relationship, since the pitch-proximity of their tones is almost the same. The harmonic value, therefore, outweighs the melodic.

In Fig. 24 the dotted line reveals what may be called the ideal curve of distribution for melodic relationship. This is based

entirely upon pitch-proximity, the major second having one-half that of the minor second; the minor third one-third that of the minor second; the major third, one-fourth; and so on. The starting point for the upper end of the curve was chosen midway between the frequency of the unison and minor second found in the test as made. (Since the form of the curve remains the same, its absolute position in the figure is immaterial.) The solid line shows the distribution as actually found. Vertical distances are per cents of frequency; unisons, for example, constituting 26 per cent of all the intervals counted, minor seconds 17½ per cent., and so on.

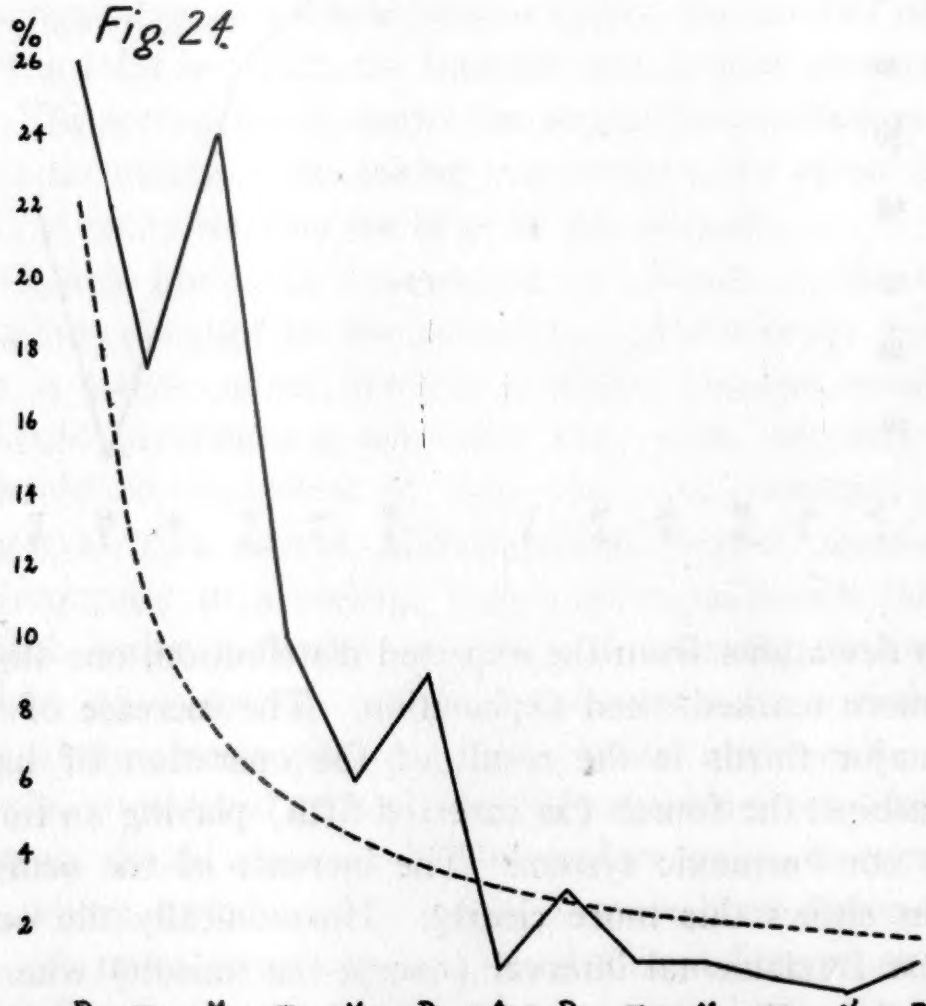


Fig. 24

The agreement of this curve with the theoretical curve is well marked, and if the real curve were presented in the form of a smoothed histogram, the agreement would be striking. The differences between the two curves may be explained as follows:

Since all songs selected were written in the tonality system of the music of Western Civilization, harmonic influences cannot be entirely excluded, particularly since the songs were written with piano (harmonic) accompaniment. This accounts for the predominance of the octave over the sevenths. Major seconds exceed minor because in our diatonic scales (the form of scale upon which the songs are based), the ratio of major to minor seconds is 5:2. Actually, in melody, this ratio is considerably reduced through the greater pitch proximity of the minor second. In the count as made the ratio is 96:70. Part of the reduction, of course, can be accounted for by the presence of the harmonic-minor tonality, in which minor and major seconds, from the standpoint of scale construction, each occur three times.

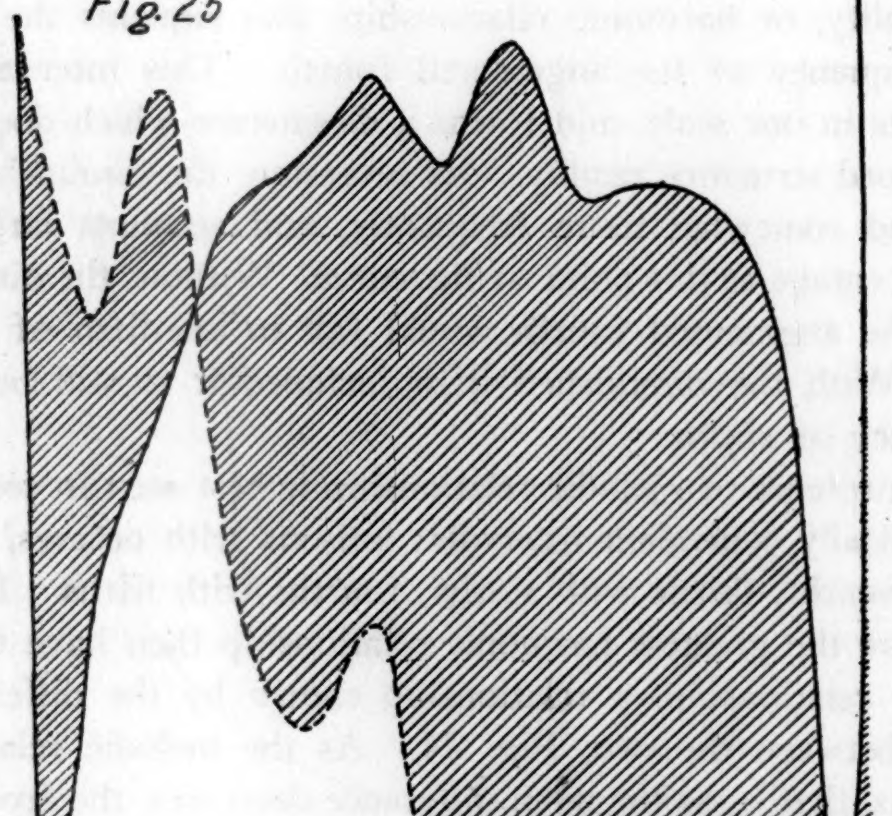
Tonality, or harmonic relationship, also explains the drop in the frequency of the augmented fourth. This interval occurs but once in our scale, and forms a dissonance which does not fit into chord structure readily. Its inversion, the diminished fifth, is found somewhat more frequently, and accounts largely for the percentage at this point of the curve. Without the diminished fifth, the augmented fourth would fall to one-fifth of one per cent. With the diminished fifth included it is still below the frequency of sixths.

The presence of melodic relationship is best seen in comparing harmonically equivalent intervals: unisons with octaves, seconds with sevenths, thirds with sixths, fourths with fifths. Intervals that have the greatest harmonic relationship then have the least melodic relationship, a relationship shown by the difference in height between the two, Fig. 24. As the melodic relationship increases, that is, as the pitch difference decreases, the frequencies of the intervals in question approach a common level. (Between unisons and octaves the difference equals 25 per cent.; between seconds and sevenths 20.7 per cent.; between thirds and sixths, 7 per cent.; between fourths and fifths, 6 per cent.) The actual percentages are variable, but the general decrease results from the operation of the basic principle of melodic relationship.

Finally, by combining the curve for melodic relationship with one for harmonic relationship, as in Fig. 25, any doubt as to the

opposition of the two forms of tonal association, the vertical and the horizontal, will be dispelled. In this figure the solid line represents the consonant (harmonic) value (equal temperament), of each interval (taken from Helmholtz, 26), and the dotted line the melodic value as found in this test. Where the dotted line is above the solid line melodic associations predominate, where the dotted line is below, harmonic values predominate. The shaded portion marks the degree to which the two forms of association do not coincide. This, it will be seen, covers a great part of the entire area of the figure, thus proving the low correlation between the harmonic and the melodic principles of tonal association.

Fig. 25




In like manner, rhythmic influences alter the melodic relationships which we have enumerated. The exclusion of objective intensity differences does not necessarily destroy subjective

rhythm. A series of absolutely even clicks, both as to intensity and to duration, may very easily be heard as groups of two, three, four, or more. Accordingly, any tones that happen to fall on a subjectively accented beat, will receive a rhythmic or metrical accent that may counteract a lack of purely melodic emphasis; or, on the other hand, they may strengthen a melodic accent already present. Since the subjective rhythm supplied by the listener may readily differ between two subjects, these rhythmic accents may fall on various tones for the same melody. These rhythmic influences cannot be entirely eliminated, but by keeping the intensity constant, and the rate of tonal succession sufficiently slow (one tone or less per second), they can be materially reduced in importance.

Tonality and intensity influences are harmonic and rhythmic problems respectively, and, as such, they fall beyond the scope of the present article. They have been briefly mentioned, however, because without them, certain discrepancies which appear in all tests for melodic reaction when compared with the unanalyzed reaction of the mature musician cannot be adequately explained. It is also advisable to mention, here, the influence of the anticipatory judgment (14). The preparation of new stimuli through anticipation may result in an added emphasis, if the stimulus coincides with the anticipation, and may require a readjustment, with its resulting confusion, if it does not. Through anticipation, a tone otherwise not emphasized, may be stressed for consciousness; and an emphasized tone may be weakened.

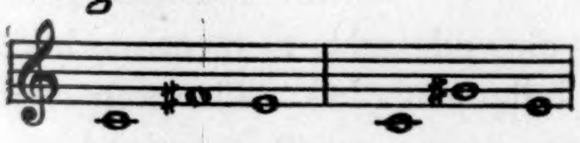
## PART IV

### Effects of Melodic Relationship

As a result of the predominance of relative over absolute pitch, and of the constantly operative psychology of the higher-unit, *it is impossible, objectively, to change a single tone of a melody without changing the psychological status of its adjoining tones, and, to a less degree, that of all other tones of the melody falling within the memory-span.*

Thus, if the following two motives be given for comparison, and the subject be required to judge whether the first, second, or third tone has been changed, the last tone of the second motive is sometimes judged as different on account of the change of interval between F♯–E and G♯–E.

*Fig. 26*



Conversely, in the following examples, the last tones are sometimes heard as the same tone since the *last interval* (descending third) is the same in both examples, Fig. 27.

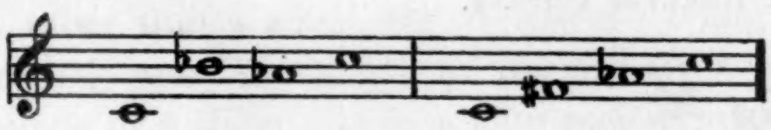
*Fig. 27*

Such an error may function regardless of the actual pitches used. In groups of only three tones, which are well within the memory span of the normal pupil, this type of error is seldom found. In longer groups, however, it is more frequently observed.

The effect of changes in pitch direction, from ascent to descent or vice versa, also introduces an error of judgment in tonal com-

parison. If we compare the two motives of Fig. 28, the third tone (A♭) is frequently heard, in addition to the second tone, as altered tone. This judgment seems to be based upon a change in pitch direction. A descending interval with its judgment of "lower than" is replaced by an ascending interval with its judgment of "higher than."

Fig. 28



The melodic line here has been changed from ascent-descent-ascent, to ascent-ascent-ascent, a change sufficiently basic to destroy, or, at least perceptibly weaken the individual status of each tone. If such a change involves, at the same time, a change from and into the highest or the lowest tone, the error is further intensified.

In comparing the two examples of Fig. 29, a more involved operation of this type of error may be seen. Here the fourth tone, in addition to or in place of the correct second tone, may be reacted to as the changed tone. This results from the association of tones two and four through pitch-proximity, which the intervening low third tone does not entirely destroy (see Fig. 20). In the first of the examples, the second tone is higher than the fourth tone, in the second example, the fourth tone is higher than the second, which results in an interchange of pitch direction similar to that outlined for Fig. 28. This error is more marked if we omit the upper E, and thus make the change of tones also a change of highest pitch, C to B♭.

Fig. 29

The effect of interval relationship is seen when we alter two tones equally in different environments. For example, in an

environment consisting only of thirds, a change of a whole-tone seems larger than the same change in an environment of larger intervals. This difference is shown in Figs. 30 and 31. In the first example, the change from C to D is one-half of the interval E–C, and one-half of the interval D–B♭. In the second example, the change from B♭ to C is also a whole-tone, but this distance forms only one-fourth of the interval D–B♭, and one-fifth of the interval B♭–G♯.

*Fig. 30*

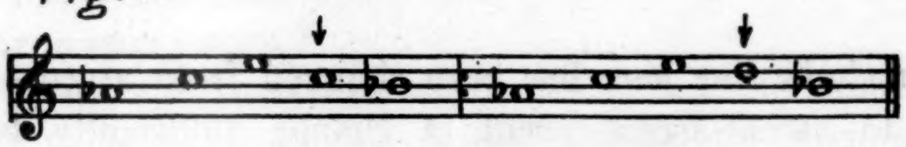
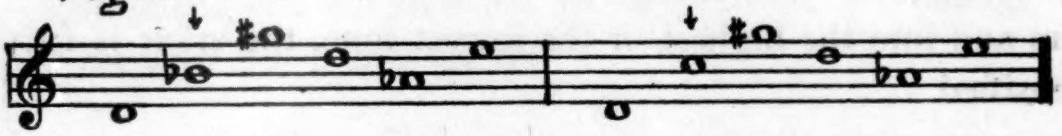


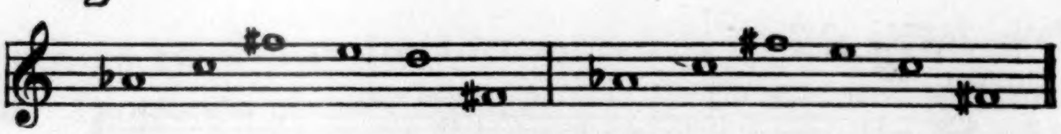
*Fig. 31*



This ratio of increment-of-change to base, seems to be one of the determinants of the judgment. For a like reason, a single large interval in a series of small intervals, is more noticeable (emphasized) than the same large interval in a series of larger intervals. The high G♯ in Fig. 21, is an illustration of this emphasis.

The element of repetition affects tonal judgments by producing a judgment of sameness versus difference of pitch, which is more fundamental than a judgment of difference in a series of differ-

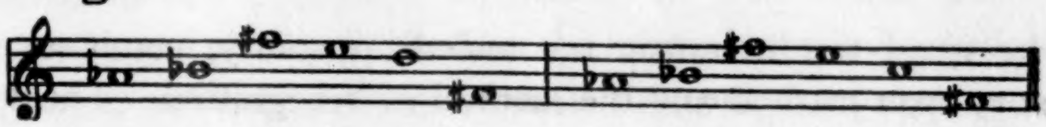
*Fig. 32*



ences. Thus in Fig. 32 the change D to C results in a repetition of the tone C, as a result of which the second C receives repetition emphasis, which automatically emphasizes the alteration itself. In Fig. 33, no repetition through the alteration occurs,

although the quantity of change remains the same. The alteration in the second part, other things equal, is therefore somewhat more difficult for the listener to detect.

Fig. 33



Finally, other things equal, the vividness of any change in a melody depends upon the length of the melody. Of two equal changes, made in a short and in a long melody, the former will always be more readily perceived than the latter (23).

## PART V

### A Test in Melodic Memory

The usual test in music for melodic memory, combines the memory-span method and the method of recognition. The span method demands that we begin with a series of auditory stimuli quite within the limit of the subject and that we increase the series until errors begin to occur, meanwhile keeping other factors constant. The method of recognition demands the representation of an altered series in which the subject points out either the altered or the non-altered stimuli.

The modest demands which such a test seems to make, at first acquaintance, are replaced by insurmountable difficulties upon closer analysis. For, if the theoretical analysis of the preceding pages be correct, then it is impossible to *"keep other factors constant,"* in any altered series.

The test here outlined was given to 128 music students, roughly divided into two classes. Class A consisted of 89 pupils, mostly children from nine to seventeen years, but containing also a few adults. Class B was an adult group (over seventeen years) of 39 pupils. In both classes all degrees of musical talent (measured both by teachers' estimates and by other more detailed tests) were represented, although, since all were students at a music conservatory, the entire group probably represents a slightly favorable selection. The method used was the memory-span plus the recognition methods. Reproduction, in which the subject reproduces the stimulus series, was not used for three reasons: it makes group presentation impossible; it adds an important vocal difficulty; and it makes actual recording and interpretation very difficult, if not impossible. Series of two, three, four, five, and six tones were given and five examples in each series were used. The subjects were provided with printed forms carrying a number for each tone, and they were instructed to draw a short dash through any tone that was changed. If, for example, a

stimulus of three tones had been given, as model, the subjects followed the figures 1, 2, 3, on the form, and crossed out the particular tone or tones heard as altered in the comparative stimulus when compared to the model. The element of writing involved in this procedure introduced no appreciable difficulty, and was found more reliable than the method which demands that the subject remember the tone until the entire melody has been given, and then write the number of the altered tone or tones.

The examples were given on a small portable organ, at uniform intensity, and at the rate of one tone per second with second silences between. This assures elimination of legato, or any overlapping of tones, which might readily introduce important difficulties. The five examples of the easiest (two-tone) melodies were given before the step to the three-tone melodies was made. And this plan was followed throughout the test. Preliminary instruction and examples assured proper understanding of the test. No rest periods were introduced, since the test consumes but little time, thus making allowance for fatigue unnecessary.

The melodies used were selected on the following basis:

1. The whole-tone scale was used in order to minimize tonality associations. The use of the half-tone as basic interval, that is to say the basing of such a test on the chromatic scale, is less satisfactory on account of the important part which the half-tone (as leading tone, for example), plays in our music system.
2. All changes involved a constant pitch difference: one whole-tone; the smallest amount possible in the system used.
3. Changes of pitch direction were kept constant. They occurred either in none of the examples of any one series or in all of the examples (one exception).
4. The ratio of changed interval to adjoining interval was kept constant for any one example.

Table I shows the percentile distribution of correct answers (the per cent. of times that the altered tone and no other was heard as altered), for Class A, and Table II, that for Class B.

TABLE I

| Example | 2 tones | 3 tones | 4 tones | 5 tones | 6 tones |
|---|---|---|---|---|---|
| 1 | 88 | 84 | 75 | 83 | 58 |
| 2 | 98 | 76 | 57 | 53 | 15 |
| 3 | 96 | 85 | 69 | 47 | 56 |
| 4 | 93 | 80 | 65 | 49 | 41 |
| 5 | 97 | 96 | 90 | 49 | 41 |

TABLE II

| Example | 2 tones | 3 tones | 4 tones | 5 tones | 6 tones |
|---|---|---|---|---|---|
| 1 | 100 | 94 | 81 | 79 | 43 |
| 2 | 100 | 87 | 58 | 38 | 28 |
| 3 | 97 | 97 | 84 | 43 | 48 |
| 4 | 100 | 89 | 74 | 38 | 30 |
| 5 | 100 | 93 | 76 | 48 | 41 |

The average distribution for the two classes is:

| | 2 tones | 3 tones | 4 tones | 5 tones | 6 tones |
|---|---|---|---|---|---|
| Class A | 93 | 83 | 70 | 56 | 40 |
| Class B | 99 | 92 | 75 | 49 | 36 |
| General Av. | 96 | 87.5 | 72.5 | 52.5 | 38 |

The range for the two classes is:

| | 2 tones | 3 tones | 4 tones | 5 tones | 6 tones |
|---|---|---|---|---|---|
| Class A | 10 | 20 | 33 | 36 | 43 |
| Class B | 3 | 10 | 26 | 41 | 30 |

This distribution of average correct replies shows the increase in difficulty with the increasing importance of relative factors as the memory-span increases. As we increase the number of tones in a melody we multiply the possibilities of relationships with other tones, thereby increasing the chances of tonal emphasis, positively or negatively. Since the attempt to keep all factors constant, except the changed tones, applied to all examples, the ideal distribution would show the same percentage for all examples of any one vertical group. We have now to explain the deviations from this distribution which the actual results show.

The deviations in the two-tone columns are too slight to demand analysis. The nearness of correct replies to 100 per cent. indicates that in the two-tone series we have the practical lower limit of tonal memory.

In order to facilitate the analysis and avoid needless repetition I shall select certain examples which deviate sufficiently from the average distribution to leave no doubt as to the influence of tonal-relationships. Where the deviation is slight, there is danger of misinterpreting the distribution, since the number of pupils tested is small, and the melodies are too short for the isolation of any one type of tonal emphasis. Consequently such examples are here excluded.

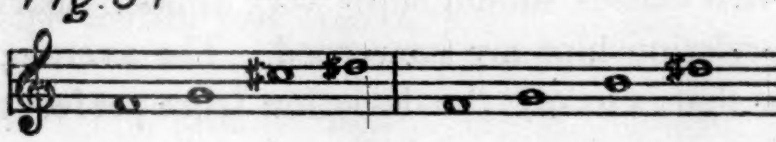
The first question that arises is whether the distributions are the result of chance conditions operating for the particular class tested, or the result of the nature of the test itself. In order to answer this, the test was given a year later to another group of adult students, Class C, from sixteen years up. The number of times each unchanged tone of each example was heard as changed (which represents a loss of imagery for that tone) was calculated, as well as the number of times the actually changed tones were heard as changed. If there were no influence of extraneous conditions, the two classes should show very similar distributions as far as tonal-relationships are concerned. The average percentile distributions, that is to say, the deviation from perfect replies, for the four-, five- and six-tone columns, for the two classes were:

| | 4 tones | 5 tones | 6 tones |
|---|---|---|---|
| Class B | 8 | 11 | 11 |
| Class C | 11 | 12 | 12 |

These numbers are the percentages of times that tones were incorrectly heard as changed tones, that is, the number of times that the memory for the tone was lost. The close agreement between the two classes, which was, incidentally, accompanied by close agreement in the range as well as in deviation for any one tone, shows that the constant factors of the test are being revealed, and that any marked deviation, therefore, is indicative of differences in the various parts of the test itself. Since about 10 per cent. represents the average error, a figure considerably less than this would mean that that tone must be well emphasized for consciousness else it could not be so readily and correctly retained. On the other hand, any figure considerably above 10

per cent. indicates that the corresponding tone is unemphasized, as a result of which the memory of it is lost. The selection of the following examples was made on this basis. Only tones were selected upon which the distributions for the three classes of pupils agreed sufficiently, and which were sufficiently removed from the average to minimize doubt as to the influence of tonal relationships. Tones accompanied by a low percentage of error are tones upon which the various types of tonal emphasis that we have considered, coincide, or upon which there is a particularly strong single emphasis. Tones yielding approximately 10 per cent. error, are tones emphasized in certain respects and unemphasized in others, constituting what we might call normal emphasis. Tones accompanied by high percentage of error are largely unemphasized, at least in comparison with other tones of the same melody. The memory error is the per cent. of times that the memory for the tone was lost.

*Fig. 34*



Tone 1. Accentuated as first and lowest tone; unaccentuated as a member of the group F–G. (The stronger the grouping, the more does the individuality of each tone merge into the whole.) Memory for this tone lost in 13 per cent. of cases.

Tone 2. Unaccentuated as pitch intermediary. Memory error, 19 per cent.

Tone 4. Accentuated as last and highest tone; unaccentuated through grouping with the preceding C♯. Memory error, 7 per cent.

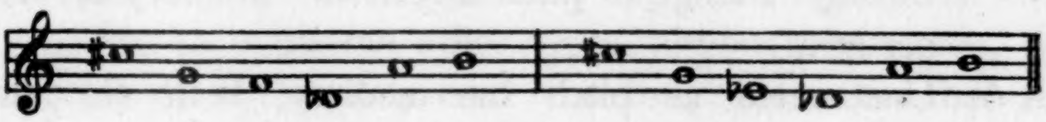
*Fig. 35*

Tone 1. Accented as first and highest tone. (Also through size of first interval.) Memory error, 3 per cent.

Tone 3. Accented slightly as first tone group E–D. Unaccented as pitch intermediary. Identity confused through result of change of interval between it and the real changed tone. Memory error, 22 per cent.

Tone 5. Accented as last tone and through isolation from preceding tone on account of wide preceding interval. Unaccented as pitch intermediary. Memory error, 13 per cent.

*Fig.36*



Tone 1. Accented as highest tone, as first tone, and through size of first interval, which clearly isolates the tone. This is a case of coincidence of emphasis on one tone. Memory error, 2 per cent.

Tone 2. Unaccented as pitch intermediary and through proximity to F. Memory error, 23 per cent.

Tone 4. Accented as lowest tone, but identity weakened through change in preceding interval. Memory error, 9 per cent.

Tone 5. Accented slightly as first tone of group A–B on account of size of interval (augmented fifth, largest interval in this melody). Unaccented as pitch and time intermediary. Memory error, 15 per cent.

*Fig.37*

Tone 1. Accentuated as first tone; as lowest tone. Accentuated as detached tone from the group E–F♯. Triple emphasis. Memory error, 1 per cent.

Tone 3. Unaccentuated as pitch intermediary. Confused with the changed tone through the change in the preceding interval. Memory error, 16 per cent.

Tone 4. Accentuated as highest tone. Accentuated through interval relationship with other intervals of the melody (diminished fifth compared to major third and second), slightly unemphasized as agogic intermediary. Memory error, 3 per cent. In this case the emphasis through size of interval (pitch isolation) is sufficiently great to overcome the non-emphasis through temporal intermediacy.

Tone 5. Unaccented as intermediate tone. Slightly accentuated through change in pitch direction. Memory error, 12 per cent.

Tone 6. Unaccented as pitch intermediary, both for entire melody and for second group: C–G♯ A♯. Accentuated as last tone. Memory error, 14 per cent.

If we average the memory errors for tones upon which the time- and the pitch-extreme emphases coincide, we get an average of 4.5 per cent. for all five- and the six-toned examples. The average for tones upon which these two types of emphases do not coincide is 13.5 for the same groups. In other words, it was noticeably easier to remember a tone, as here presented, when the tone was accented both as first and highest or lowest tone, than when it was accented as one but not at the same time as the other.

The effect of interval memory is seen in the relative ease with which the changed tone is recognized if the change introduces an interval previously not present in the melody. Thus, if we count a whole-tone as 1, a major third as 2, an augmented fourth (diminished fifth) as 3, and so on, a change from 2–2–1–4 to 2–1–2–4 will be less noticeable than a change from 2–1–2–2 to 2–1–3–1, because in the former case the change is merely an *interchange* of intervals, while in the latter case the change introduces a new interval, although both represent the same absolute amount of pitch change: one whole-tone. The explanation can also be made on the basis of pitch-proximity, since the introduc-

tion of a large interval into a group of small intervals results in a strengthening of tone-groups, the first tones of which become correspondingly more accentuated, and hence easier of retention.

It is inadvisable, in the examples used, to attempt to show the other types of emphases such as that of pitch-direction, because the longest were only of six tones, which is too short to introduce one type of emphasis without involving other types for the same tone. Moreover, changes in pitch direction were purposely avoided wherever possible in this test. The emphasis which a tone receives through a change in pitch direction, for example, might be complicated by enforced tone-repetition or pitch-proximity, which would make an isolated treatment impossible. In the examples here given, a particular type of emphasis is sufficiently strong to overcome other types, although here, too, the tone is probably not entirely free from emphases other than the major ones to which the status of the tone has been attributed.

For this reason I have selected only those examples in which marked deviation from the average makes ambiguity rather improbable, but not impossible. This restriction is doubly advisable because no attempt has been made to define the absolute value of any type of emphasis, nor has the test been given to a sufficiently large number of students to make the results certain. Then, too, the inevitable harmonic associations operate. The agreement of the results in all essentials with the theoretical deduction preceding them, and the absence of any major discrepancy in the test itself, point to a reasonable degree of reliability. The test is not included for a too literal acceptance, since it has to be repeated on a much larger scale before its value can be established; it serves, however, as a preliminary check on the general laws of melodic relationship.

## CONCLUSIONS

1. The psychological status of any tone in any melody is determined by its tonal environment, and by its absolute position in the pitch and in the time series.

2. No one tone of any melody can be changed without thereby changing, to a great or small extent, the status of every other tone in the melody.

3. No two tones, in any melody, have the same psychological status.

4. Whenever two or more types of emphasis coincide upon a tone, that tone " stands out " from the rest. When the types of emphasis do not coincide, or, when one type is in conflict with another, that tone is obscured by its environment.

5. The psychological status of any tone in a melody is not a constant. It changes as each new tone of the melody is heard.

6. The melodic relationship of tones is based upon pitch-proximity, with which it varies directly.

7. Any succession of tones, as used in music, is never reacted to purely melodically. Harmonic and rhythmic relationships, either expressed or implied, are always present to modify the purely melodic effects.

8. When a test is given as herein described, a melodic memory of only two tones may be considered very inferior; one of four tones, normal, and one of six tones, superior.

9. The number of tones in a melody is not in itself a complete determinant of the memory-span. Melodies with equal numbers of tones may still differ in the ease with which they are retained.

10. Melodic memory is one element of musical talent, and may be sufficiently isolated to permit separate grading.

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